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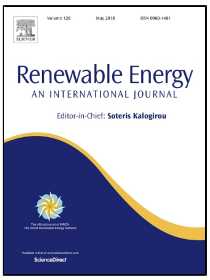

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Optimization of H-Rotor Darrieus Turbines' Mutual Interaction in Staggered Arrangements

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Abstract

Wind farms with staggered aligned wind turbines have been considered for decades to minimize the effect of turbine wake on the aerodynamic performance of its subsequent turbines. Given the numerous advantages of the Vertical Axis Wind Turbines (VAWTs), it is significant to study the feasibility of implementing them in large-scale wind farms. Therefore, the present work numerically investigates the mutual interaction between H-rotor Darrieus turbines in staggered wind farms and standalone clusters. Different layouts and configurations were thoroughly investigated by solving the Unsteady Reynolds Averaged Navier–Stokes (URANS) equations under different geometric and operating conditions. The objective of the present work is to maximize the power output of the VAWTs' wind farms while reducing the required land area. This objective was achieved by defining the spacing between turbines that reduces the wake losses and minimizes the mutual interaction between the VAWTs in staggered wind farms. At this spacing, the power coefficient of the individual turbines is closer to that of an isolated turbine. Moreover, the spacing that optimizes the power density of standalone clusters was estimated.

Key Word: Wind Energy, VAWT, Wind Farm, CFD, Optimization

1. Introduction

Recently, the need for clean energy started to attract more interests due to the harmful impacts of the fossil fuels on the environment and the highly pressing warnings of global warming. Therefore, wind energy has been introduced as a key player in the field of clean renewable energy as an alternative to fossil fuels. Khan et al. [1] discussed the advantages of using the wind energy to generate electricity in lieu of the conventional fossil fuels. Wind energy has been considered a common natural resource of energy for at least 3000 years [2]. Small-scale wind turbines are currently getting more attention because large-scale wind farms have potential effects on the environment [3]. An intensive review of small-scale Vertical Axis Wind Turbines (VAWT) was presented in [3, 4]. Wind turbines can be classified according to the

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